WHAT IS CLAIMED IS:

1. A signal transmission apparatus, comprising:

a signal transmission line having a transmitting end, a receiving end, and a characteristic impedance, including a signal-line element having a resistance-capacitance delay, for transmitting a digital signal input at the transmitting end;

a first driver having an inverter structure and an on-resistance, for supplying the digital signal to the transmitting end of the signal transmission line;

a power-ground transmission line pair for supplying power to the first driver, having a characteristic impedance low enough to drive a sum of the on-resistance of the first driver and the characteristic impedance of the signal transmission line;

a first receiver having a differential amplifier structure, for receiving the digital signal from the receiving end of the signal transmission line and detecting the received digital signal; and

a first directional coupler connected between the first driver and the transmitting end of the signal transmission line, or between the receiving end of the signal transmission line and the first receiver, for blocking a direct-current component of the digital signal and passing a wideband alternating-current component of the digital signal.

2. The signal transmission apparatus of claim 1, wherein all signal-line elements from output interconnections in the first driver to input interconnections in the first receiver, including all signal-line elements in the signal transmission line and all signal-line elements in the first directional coupler, are metallic.

3. The signal transmission apparatus of claim 1, wherein a transmission line structure is maintained in all signal-line elements from output interconnections in the first driver to input interconnections in the first receiver, including all signal-line elements in the signal transmission line and all signal-line elements in the first directional coupler.

4. The signal transmission apparatus of claim 1, wherein the first directional coupler includes an energy input line pair and an energy transmitting line pair, both having a predetermined length, disposed in close proximity in materials of different dielectric constants, the energy input line pair being separated from the energy transmitting line pair by a predetermined gap.

5. The signal transmission apparatus of claim 4, wherein the material in which the energy input line pair is disposed has a higher dielectric constant than the material in which the energy transmitting line pair and surrounding interconnecting lines are disposed.

6. The signal transmission apparatus of claim 4, wherein the energy input line pair is disposed in air or another material having a lower dielectric constant than the material in which the energy transmitting line pair and surrounding interconnecting lines are disposed.

7. The signal transmission apparatus of claim 1, wherein the first directional coupler is connected between the receiving end of the signal transmission line and the first receiver, and no directional coupler is connected between the first driver and the transmitting end of the signal transmission line.

8. The signal transmission apparatus of claim 7, wherein the first directional coupler includes an energy input line pair having an open and floating output end and an energy transmitting line pair having an open and floating input end.

9. The signal transmission apparatus of claim 1, wherein the first directional coupler is connected between the first driver and the transmitting end of the signal transmission line, further comprising a second directional coupler connected to the receiving end of the signal transmission line.

10. The signal transmission apparatus of claim 9, wherein:

the second directional coupler is connected between the receiving end of the signal transmission line and the first receiver;

the first directional coupler includes a first energy input line pair having an open and floating output end and a first energy transmitting line pair having an open and floating input end; and

the second directional coupler includes a second energy input line pair having an open and floating output end and a second energy transmitting line pair having an open and floating input end.

11. The signal transmission apparatus of claim 9, wherein:

the first receiver is connected directly to the receiving end of the signal transmission line;

the first directional coupler includes a first energy input line pair having an open and floating output end and a first energy transmitting line pair having an open and floating input end; and

the second directional coupler includes a second energy input line pair having an open and floating output end and a

second energy transmitting line pair having an open and floating input end;

further comprising a terminating resistor connected across an output end of the second energy transmitting line pair, for preventing signal reflection.

12. The signal transmission apparatus of claim 11, wherein the second directional coupler and the terminating resistor are metallic.

13. The signal transmission apparatus of claim 1, wherein the first directional coupler is connected between the first driver and the transmitting end of the signal transmission line and no directional coupler is coupled to the receiving end of the signal transmission line.

14. The signal transmission apparatus of claim 13, wherein:

the first directional coupler includes a first energy input line pair having an open and floating output end and a first energy transmitting line pair having an open and floating input end; and

the first receiver is connected directly to the receiving end of the signal transmission line;

further comprising a terminating resistor connected across the receiving end of the signal transmission line, for preventing signal reflection.

15. The signal transmission apparatus of claim 14, wherein the first directional coupler and the terminating resistor are metallic.

16. The signal transmission apparatus of claim 1, wherein the first driver includes a p-channel metal-oxide-semiconductor (MOS) transistor and an n-channel MOS

transistor connected to form an inverter.

17. The signal transmission apparatus of claim 1, wherein the first driver includes:

a pair of n-channel MOS transistors connected to form an inverter; and

a pair of inversion mode MOS varactors for pumping a source-drain capacitance of the n-channel MOS transistors up and down.

18. The signal transmission apparatus of claim 1, wherein the first receiver comprises:

a substrate; and

a differential pair of input MOS transistors disposed in a single well, the single well being electrically isolated from the substrate.

19. The signal transmission apparatus of claim 18, wherein the first receiver further comprises a current control MOS transistor having a drain supplying current to the differential pair of input MOS transistors, the drain also being coupled to the single well in which the differential pair of input MOS transistors are disposed, thereby providing a back gate bias for the differential pair of input MOS transistors.

20. The signal transmission apparatus of claim 1, wherein the first receiver comprises:

a differential pair of input transistors; and

a latch circuit connected as an output stage to the differential pair of input transistors.

21. The signal transmission apparatus of claim 1, wherein the characteristic impedance of the signal transmission line

is uniform from the transmitting end to the receiving end.

22. The signal transmission apparatus of claim 1, wherein the signal transmission line is disposed in a homogenous dielectric material having a uniform dielectric constant.

23. The signal transmission apparatus of claim 1, wherein the signal transmission line is a stacked-pair transmission line, a pair-coplanar transmission line, or a guarded coplanar transmission line.

24. The signal transmission apparatus of claim 1, wherein the signal transmission line satisfies the following condition, in which L denotes signal line length, λ denotes a sinewave signal component wavelength, v denotes an electromagnetic wave velocity on the signal transmission line, and f denotes a maximum frequency of a pulse signal transmitted on the signal line:

$$L \geq (1/40)\lambda = (1/40)(v/f).$$

25. The signal transmission apparatus of claim 1, wherein the signal transmission line satisfies the following condition, in which d denotes a distance between facing sides of a pair of signal-line elements in the signal transmission line, w denotes a conductor width of the facing sides, t denotes a conductor thickness, and s denotes a spacing between adjacent signal transmission lines:

$$2wd < ts.$$

26. The signal transmission apparatus of claim 1, wherein the power-ground transmission line pair supplies electrical energy to n first drivers, where n is a positive integer,

and the characteristic impedance Z_{0p} of the power-ground line pair and the characteristic impedance Z_{0s} of the signal transmission line satisfy the following condition:

$$Z_{0p} < Z_{0s}/n.$$

27. The signal transmission apparatus of claim 1, wherein the first driver, the signal transmission line, the first directional coupler, and the first receiver are formed in a single semiconductor chip.

28. The signal transmission apparatus of claim 1, wherein the first driver and the first receiver are formed in different semiconductor chips, and an interconnection structure including the signal transmission line and the first directional coupler is disposed between the chips.

29. The signal transmission apparatus of claim 1, wherein the signal transmission line is branched at both its transmitting end and its receiving end for bi-directional signal transmission, further comprising:

a second driver having an inverter structure and an on-resistance;

a second directional coupler coupling the second driver to the receiving end of the signal transmission line; and

a second receiver having a differential amplifier structure, coupled to the transmitting end of the signal transmission line to receive a signal transmitted by the second driver.

30. An interconnection structure included in a logic circuit or a memory circuit, for transmitting a digital signal, comprising:

a signal transmission line having a transmitting end

and a receiving end, including a signal-line element having a resistance-capacitance delay, for transmitting the digital signal; and

a directional coupler connected to the transmitting end or the receiving end of the signal transmission line, for blocking a direct-current component of the digital signal and passing a wideband alternating-current component of the digital signal.